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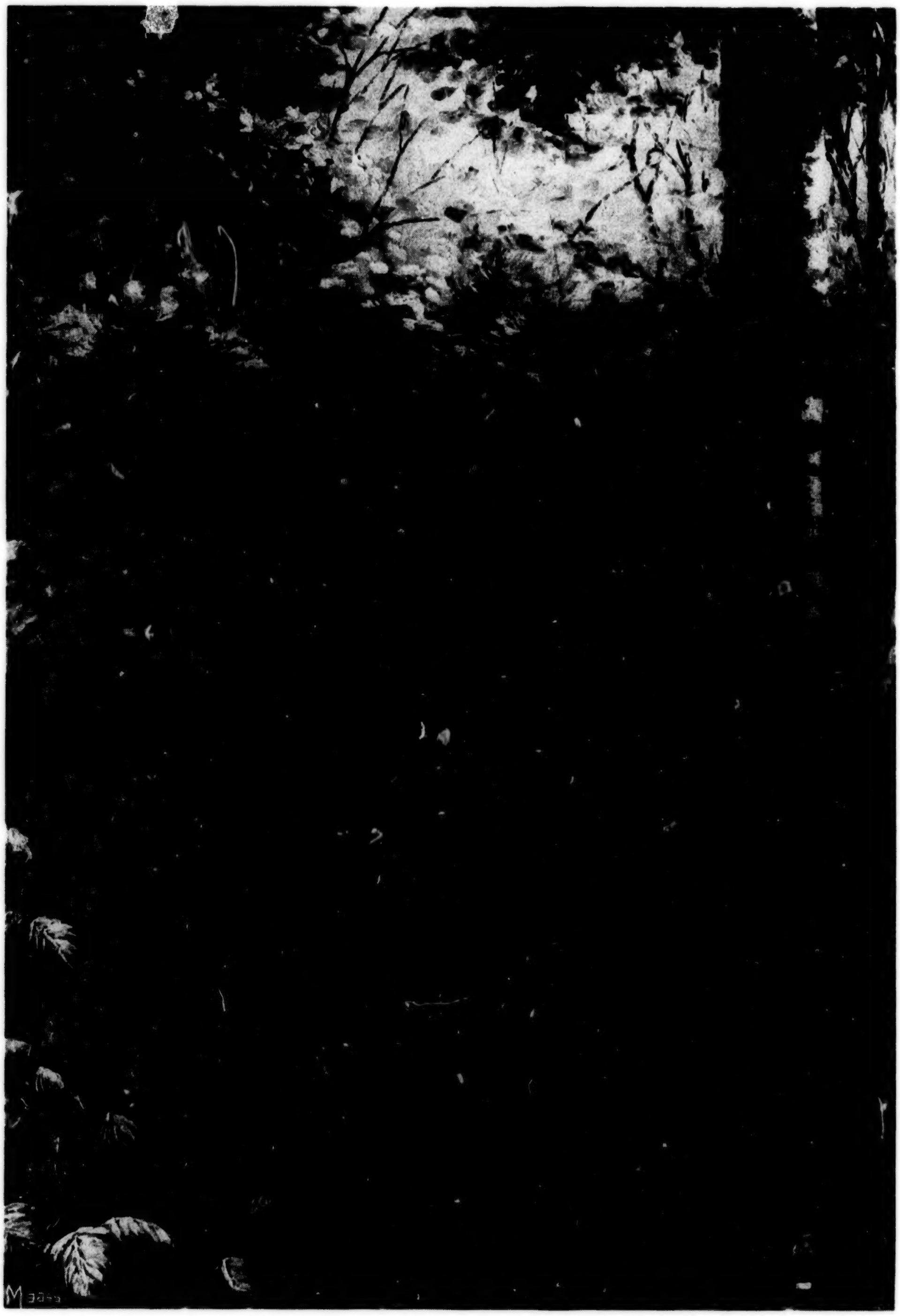
American Woodcock

Harvest and Breeding Population Status, 1992



Department of the Interior

U.S. Fish & Wildlife Service

COMPLETED

AMERICAN WOODCOCK HARVEST AND BREEDING POPULATION STATUS, 1992

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Abstract: Wing-collection and Singing-ground Surveys were conducted to determine the population status of American Woodcock. Age-ratio information from harvested woodcock indicated that the 1991 recruitment index (ratio of immatures to adult females) was near the long-term average for the Eastern Region and slightly lower than the long-term average for the Central Region. In the U. S. portion of the Eastern Region, the 1991 recruitment index was 1.8 immatures per adult female (5.9% above the 1963-91 average). The 1991 recruitment index for the Central Region was 1.6 (11.1% below the 1963-91 average). Between 1990 and 1991, the only change in Federal frameworks for woodcock hunting regulations was a shifting of the closing date from February 28 to January 31. As a result of this change, the framework closing dates of the Eastern and Central Regions were concurrent. Indices of hunting success (average daily and seasonal bags) continued to decline in the Eastern Region but did not change in the Central Region. Daily hunting success in the Eastern Region declined from 1.9 in 1990 to 1.7 woodcock bagged per day in 1991 (−10.5%), while the seasonal success index declined from 8.2 to 7.3 woodcock bagged per season (−11.0%). In the Central Region the daily success index remained at 2.3 birds per day in 1990 and 1991, while the seasonal success index remained at 11.6 woodcock bagged per season. Analysis of Singing-ground Survey data using route regression methodologies indicated a significant ($P<0.01$) decrease of 16.1% between 1991 and 1992 and a significant ($P<0.01$) long-term (1968-92) decline of 1.9% per year in the Eastern Region. Route regression results for the Central Region breeding population showed a significant ($P<0.01$) decrease between 1991 and 1992 of 16.8% and a non-significant ($P>0.10$) long-term decline of 0.8% per year. Comparison of recent (1985-92) versus historical trends (1968-84) of the Singing-ground Survey suggested that the rate of decline between these periods was different for the Eastern Region. Slopes of the breeding indices in recent years (1985-1992) were not significantly different from zero for either region ($P>0.10$). This suggests that woodcock populations may be stabilizing in both regions. However, this is not true for individual states within the survey area. During the past 8 years, breeding population indices of woodcock declined significantly ($P<0.10$) in Connecticut, Maine, Massachusetts, New Jersey and Wisconsin. Conversely, the index for Indiana increased significantly over this time period ($P<0.10$).

The American woodcock (*Scolopax minor*) is a popular game bird throughout eastern North America, providing an estimated 3.4 million person-days of recreational hunting annually (U.S.D.I. 1989). As stated in the recently released *American Woodcock Management Plan*, the management objective of the U.S. Fish and Wildlife Service (FWS) is to increase population levels of woodcock to levels consistent with the demands of consumptive and non-consumptive users. To meet this objective, and to conform with the requirements of the Migratory Bird Treaty Act, the FWS in cooperation with the Canadian Wildlife Service (CWS) and 39 state and provincial fish and wildlife agencies conducts two annual surveys of woodcock populations — the *Wing-collection Survey*, and the *Singing-ground Survey*. These surveys allow biologists to monitor the status of woodcock populations and aid wildlife administrators in setting harvest regulations.

The primary purpose of this report is to facilitate the prompt distribution of timely information. Results are preliminary and may change with the inclusion of additional data.

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The *Wing-collection Survey* is a cooperative effort between woodcock hunters, FWS, and state wildlife agencies. Each fall, a sample of hunters submit one wing from each woodcock they bag to FWS and provide supplemental information on their hunting success. The data collected in this survey provide information on woodcock recruitment (productivity) during the previous spring as measured by the relative abundance of juvenile woodcock in the bag. This survey also provides an index to hunter success rates during the previous hunting season.

The *Singing-ground Survey* provides an index to the current year's breeding population. This survey is conducted by hundreds of government employees and volunteers from the United States and Canada. Because the routes were randomly located and are run each year, the survey provides an index to the total breeding population in the surveyed area. Accordingly, this survey reflects the combined effects of trends in the total amount of available woodcock habitat and the relative abundance of birds in that habitat.

Although the Wing-collection Survey and the Singing-ground Survey are imperfect in several respects, they provide the best information on woodcock population status currently available. The FWS is investigating improved methodologies in an effort to provide better information to biologists and administrators in the future.

METHODS

Reliable annual estimates of population size, productivity, harvest size and distribution are fundamental to comprehensive woodcock management. Unfortunately, this information is difficult and often impractical to obtain. Woodcock are difficult to find and count because of their cryptic coloration, small size, and preference for densely vegetated habitat. Also, no comprehensive sampling frame for woodcock hunters exists. Because of these difficulties, the Wing-collection Survey and Singing-ground Survey were developed to provide indices of populations, productivity and harvest levels.

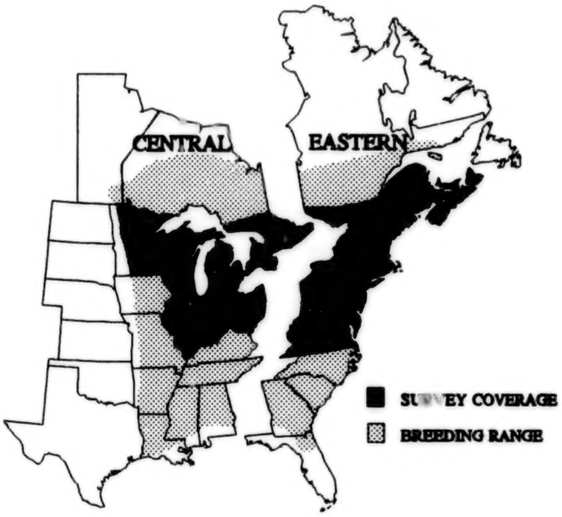

Fig. 1. Woodcock management regions, breeding range, and Singing-ground Survey coverage.

Woodcock Management Units

Woodcock breed throughout most of eastern North America (Owen 1978). However, woodcock biologists have traditionally recognized two relatively discrete populations, as defined by Glasgow (1958), Martin et al. (1969), and Krohn et al. (1974) (Fig. 1). Because detailed analyses of band recovery data support the existence of these populations as relatively discrete units (Coon et al. 1977), Eastern and Central Regions were designated for administrative purposes. Accordingly, the results of the Wing-collection Survey and Singing-ground Survey were reported separately for each management unit.

Wing-collection Survey

The Wing-collection Survey was developed in the early 1960's to monitor the productivity of woodcock. In the absence of a method for selecting woodcock hunters at random, woodcock hunters were solicited from state fish and game agencies and from Federal duck stamp purchasers who indicated that they also hunt woodcock. Survey participants included hunters who: (1) participated in the previous year's survey; (2) requested that they be included in the survey; or (3) indicated on a state or Federal harvest survey that they hunted woodcock in the previous hunting season.

Wing-collection Survey participants were provided with prepaid mailing envelopes and asked to submit one wing from each woodcock they bagged. In addition, the hunters were asked to record the effort and success of their hunts. Age and sex ratios in the harvest were determined by examining plumage characteristics (Martin 1964) during the annual FWS "wingbee" (a cooperative work session). The ratio of immature birds per adult female provided an index to production during the 1991 breeding season. Annual indices were compared to the long-term (1963-91) ratio of immatures per adult female. Annual indices were calculated as the average number of immatures per adult female in each state, adjusted for the relative contribution of each state to the number of wings received in 1963-91. In order to ensure comparability between annual indices, the state indices were weighted so that the relative contribution of each state to any given annual index was the same as in the 1963-91 total.

The daily and seasonal bags of hunters who participated in the Wing-Collection Survey in 1990 and 1991 were used as indices of hunter success. These indices were weighted to compensate for differences in the proportion of the estimated woodcock harvest attributable to each state and adjusted to a base-year value for comparison with previous years. Further information on this weighting technique can be found in Clark (1970, 1972, 1973).

Singing-ground Survey

The Singing-ground Survey was developed to exploit the conspicuous courtship display of the male woodcock. Early studies demonstrated that counts of singing males provide indices to woodcock populations and can be used to monitor annual changes (Mendall and Aldous 1943, Goudy 1960, Duke 1966, and Whitcomb 1974). Before 1968, counts were conducted on non-randomly located routes. Beginning in 1968, routes were relocated along lightly traveled secondary roads in the center of randomly chosen 10-minute blocks within each state and province in the central and northern portions of the woodcock's breeding range (Fig. 1). Data collected before 1968 is not included in this report due to potential biases.

The current survey consisted of approximately 1,500 routes. The routes were 3.6 miles long, consisting of 10 listening points. The routes were surveyed shortly after sunset by driving to each of the 10 stops. At each stop, the observer recorded the number of woodcock heard "peenting". The survey dates were selected to coincide with peaks in courtship behavior of local woodcock. In most states, the actual peak of singing activity (including local and migratory woodcock) may have occurred earlier in the spring and in some situations, local reproduction may have already been underway. However, it was necessary to conduct the survey during the designated dates in order to avoid counting migrating woodcock. Because adverse weather conditions may affect singing behavior or listening conditions, surveys were only conducted when wind, rain, and temperature conditions were acceptable.

In order to avoid expending unnecessary manpower and funds, approximately one half of the 1,500 Singing-ground Survey routes were run each year. The balance of these routes were carried as "constant zeros." Routes for which no woodcock were heard for at least two consecutive years entered this constant zero status and were run once every 5 years until woodcock were heard. Once woodcock were heard, the route entered a normal status and was again run each year. Data from constant zero routes were included in the analysis only for the years they were actually surveyed. Sauer and Bortner (1991) reviewed the implementation and analysis of the Woodcock Singing-ground Survey in more detail.

Route Regression Methodology. -- Trends were estimated for each route by fitting a line using linear regression of the natural logarithm of the original counts +0.5 (Geissler 1984, Geissler and Sauer 1990) versus year. Observer data were used as covariables in the regression to adjust for differences in observers' ability to hear woodcock. To estimate state and regional trends, the slope estimates of the individual routes were back-transformed and weighted average slopes were calculated for the areas of interest as described by Geissler (1984). Regional estimates were weighted by state and provincial land areas. Variances associated with the state, provincial, and regional slope estimates were estimated using a bootstrap procedure (Efron 1982). The weighted geographic slope estimates were expressed as percent change per year. Trend significance was assessed using *Z* based confidence intervals with $P<0.10$. See Sauer and Bortner (1991) for a detailed description of this method as applied to the woodcock Singing-ground Survey.

The reported sample sizes are the number of routes on which a given trend estimate is based. This number may be less than the actual number of routes run for several reasons. Route regression analyses cannot use routes on which no birds were heard during the interval of interest, hence these routes were not included in the sample size. Occasionally, some stops occurred before or after the peak times of woodcock singing activity. Only route observations with at least 9 stops surveyed during the peak times were included in the analysis. Routes for which data were received after June 1, 1992 were not included in this analysis but will be included in future long-term trend estimates.

Annual Indices Estimation. -- Annual indices were calculated for the two regions and each state by finding the deviation between the observed count on each route and that predicted by the regional or state trend estimate. These residuals were averaged by year and added to the fitted trend to produce annual indices of abundance for each region or state. Therefore, yearly variation in woodcock abundance was superimposed on the long-term fitted trends. (See Sauer and Geissler 1990.) The advantage of this method is that the indices provide a realistic representation of annual variation about a fitted trend. In order to estimate the percent change from 1991 to 1992, a short-term trend (2 years) was calculated. The percent change estimated from this short-term trend analysis is the best estimator of annual change. Attempts to estimate short-term trends from the breeding population indices (which were derived from residuals of the long-term trends) will yield less precise results.

Recent vs. Historical Trends. -- Recent trends in the Singing-ground Survey (1985-92) were compared to historical trends (1968-84). The choice of a change-point for this comparison was somewhat arbitrary, but 1985 was chosen because significant regulatory changes were enacted in the Eastern Region in that year due to the poor population status of woodcock in that region. This comparison was not intended to imply that a relationship exists between woodcock population trends and the effects of harvest regulations. However, it is pertinent to evaluating the status of woodcock in the Eastern Region relative to a time when populations were considered to be low.

RESULTS

Wing-collection Survey

Five-thousand, eight hundred and seventy-five (5,875) potential woodcock hunters were contacted and asked to participate in the 1991-92 Wing-collection Survey. Thirty-four percent (Table 1) cooperated by submitting 15,039 wings (Table 2) and supplemental information on 3,987 hunts (Table 3). Northern hunters submitted more wings than southern hunters, leading to an unbalanced geographic distribution in the wing sample.

Recruitment. -- The ratio of immature woodcock to adult females in the harvest provides an index of recruitment to the population during the previous breeding season. In the United States' portion of the Eastern Region the recruitment index of 1.8 immatures per adult female was near the long-term average (+5.9%, Table 2). Meanwhile, the recruitment index in the United States' portion of the Central Region was 1.6 (11.1% below the long-term average; Table 2).

In order to evaluate annual variation in the recruitment index, the ratio of immature birds to adult females was calculated for the period 1963-91. This index served as a standard against which annual indices could be evaluated (Fig. 2). The ratio of immatures per adult female observed in the 1991 wingbee was nearly identical to the 1963-91 index for both regions, suggesting that recruitment during the spring-summer of 1991 was average.

Hunting Success. – Between 1990 and 1991, the only change in Federal frameworks for woodcock hunting regulations was a change in the Central Region closing date from February 28 to January 31. As a result of this change, the closing date of the Eastern and Central Regions were concurrent. Indices of hunting success (average daily and seasonal bags) continued to decline in the Eastern Region, but showed little change in the Central Region. Eastern Regional daily success declined from 1.9 in 1990 to 1.7 woodcock bagged per day in 1991 (-10.5%, Table 3), while the seasonal success index declined from 8.2 to 7.3 woodcock bagged per season (-11.0%). The base-year adjusted indices of daily and seasonal hunting success remain below the long-term average in the Eastern Region (Figs. 3 and 4). In the Central Region the daily success index remained at 2.3 birds per day in 1990 and 1991, while the seasonal success index remained at 11.6 woodcock bagged per season (Table 2). The base-year adjusted index of daily hunting success in the Central Region remains near the long-term average while the index of seasonal hunting success has remained below the long-term average (Figs. 3 and 4).

Singing-ground Survey

Route Regression. – Many observers reported that the Spring of 1992 was characterized by cooler than normal temperatures in the northern portions of the woodcock breeding range. Short-term (1991-92) trend analysis showed significant ($P<0.10$) decreases in number of woodcock heard per comparable route in Maine, Maryland, New Hampshire, New York, Pennsylvania, Vermont, Michigan, Minnesota, Ontario, and Wisconsin. There were significant declines noted for both the Eastern (-16.1%) and Central (-16.8%) Regions ($P<0.01$, Table 4 and Fig. 5).

Long-term (1968-92) trends were computed from 673 routes in the Eastern Region and 651 routes in the Central Region. In the Eastern Region, significant ($P<0.10$) long-term declining trends were noted for Connecticut, Maine, Maryland, Massachusetts, New Brunswick, New Jersey, Nova Scotia, Pennsylvania, Rhode Island, Vermont, Virginia and the entire region (Table 4). A significant long-term increase was noted for Quebec ($P<0.05$). The long-term trend for the Eastern Region indicates a mean annual decline of -1.9% per year ($P<0.01$) (Table 4 and Fig. 6).

In the Central Region, significant ($P<0.10$) long-term (1968-92) declining trends were noted for Ohio and Wisconsin. The long-term trend for the Central Region was a non-significant decline of -0.8% per year ($P>0.10$).

Annual Breeding Population Indices. -- The 1992 Eastern Region breeding population index of 1.86 singing males per route is below the predicted index of 1.96 singing males per route and was the lowest on record (Fig. 7). The Central Region population index of 2.26 males per route is below the predicted index of 2.48 males per route (Fig. 7).

Recent vs. Historical Trends. -- The Eastern and Central Region breeding population trends for 1985-92 were not significantly different from zero ($P>0.10$). However, Connecticut, Maine, Massachusetts, New Jersey and Wisconsin had significantly decreasing trends from 1985-92. The breeding population index for Indiana increased during this time period (Table 4).

DISCUSSION

Wing-collection Survey

Previous indications of a long-term decline in the Central Region recruitment index appear to have been an artifact of the base-year method

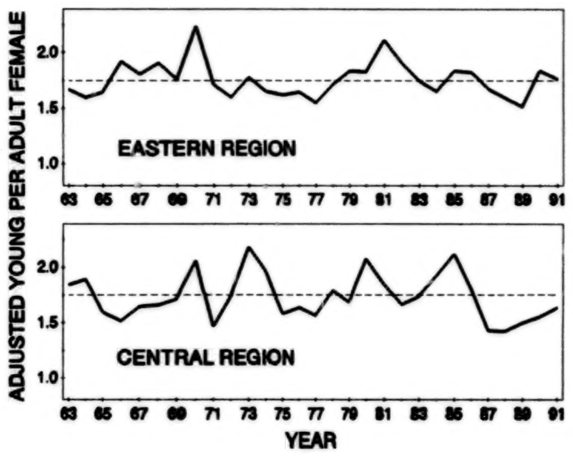

Fig. 2. Adjusted indices of recruitment, 1963-1991. Dashed line is the index based on all years, 1963-91.

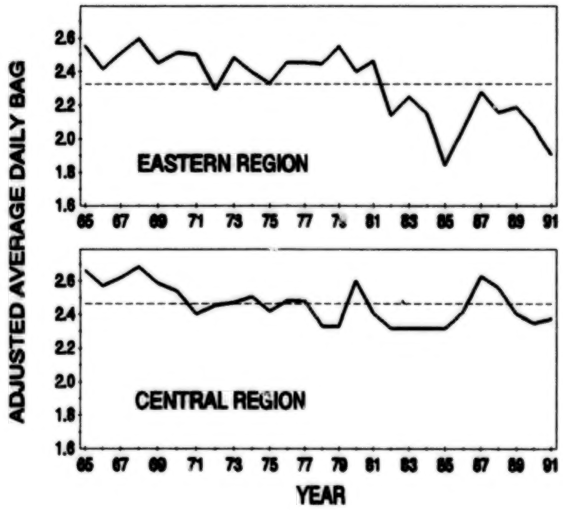

Fig. 3. Base-year adjusted indices of daily hunting success, 1965-91. Base-year is 1969. Dashed line is the 1965-90 average.

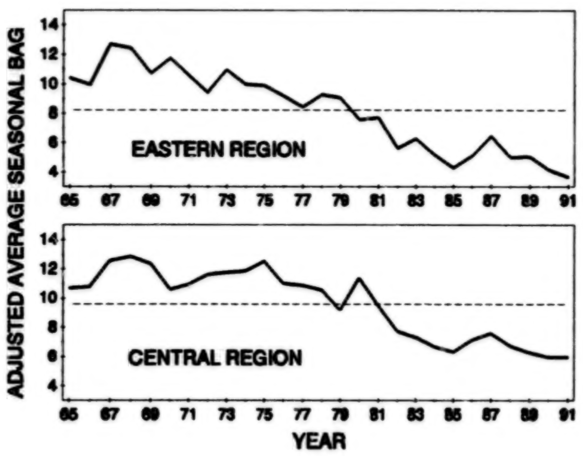

Fig. 4. Base-year adjusted indices of seasonal hunting success, 1965-91. Base-year is 1969. Dashed line is the 1965-90 average.

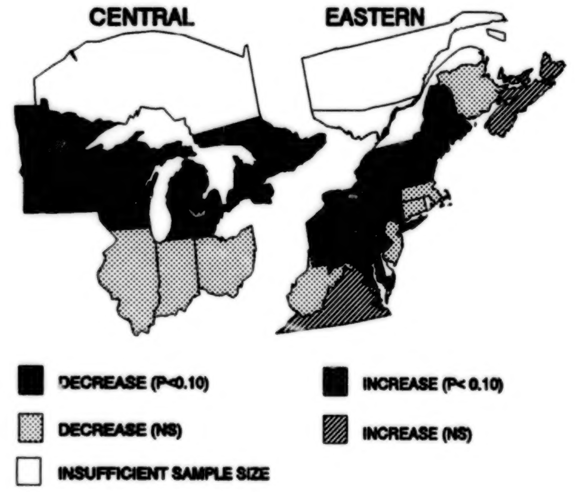

Fig. 5. Short-term trends in number of American woodcock heard on the Singing-ground Survey; 1991-92.

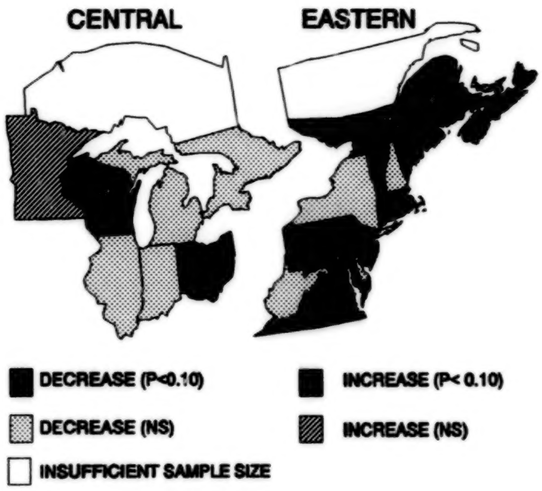

Fig. 6. Long-term trends in number of American woodcock heard on the Singing-ground Survey; 1968-92.

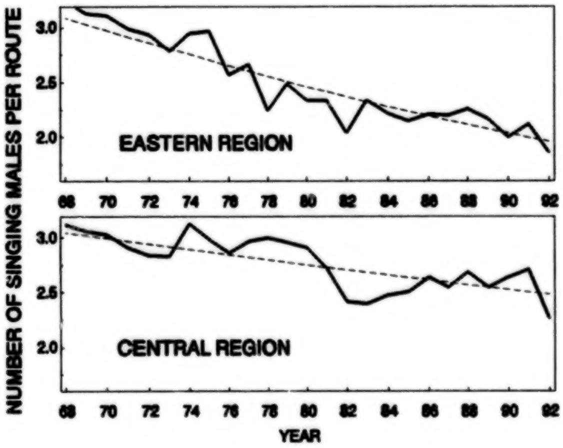

Fig. 7. Long-term trends and annual indices of number of woodcock heard on woodcock Singing-ground Survey, 1968-92.

and associated weighting procedure. Bortner (1990) found that age-ratio trends which were not base-year adjusted appeared to be stable. The results of this study also suggested no biologically significant trend in recruitment indices over time. Weather on the breeding grounds was not exceptional and recruitment during the spring and summer of 1991 was normal.

Both daily and seasonal indices of hunting success continued to decline in the Eastern Region. These trends are consistent with a general population decline of woodcock in the Eastern Region. In the Central Region, seasonal success has remained below the long-term average since 1982 while daily hunting success has not changed dramatically. This suggests that the number of days cooperators spent hunting woodcock in the Central Region has declined over the long-term.

Indices based on the Wing-collection Survey should be interpreted cautiously in light of the potential biases associated with the non-random sampling procedure by which survey participants were selected. Although not quantified, these biases may have had serious effects on the results of this survey. A comprehensive critique of these problems is beyond the scope of this report, so readers are directed to Owen (1978). Development of a statistically valid sampling frame is vital to improving this aspect of woodcock management.

Singing-ground Survey

The decline in the number of woodcock heard in 1992 may have been due to a decline in the number of male woodcock displaying on the singing grounds or to weather related effects on the behavior of woodcock. However, because the quantitative effect of atypical spring weather on woodcock "peenting" behavior is not known, it is difficult to attribute the observed decline to a specific cause.

The apparent stabilization of breeding population trends in both regions during the past 8 years is encouraging, but it should be noted that the breeding indices for most states in the Eastern Region have declined significantly over the long-term (1968-92) and for many states, this decline has also been evident during the past 8 years

(1985-92). Due to the ephemeral nature of woodcock habitat, continual maintenance and creation of habitat is critical if woodcock populations are to be maintained at their current level. Implementation of sustained-yield forest management on public and private lands is one key to maintaining woodcock populations and biological diversity within the woodcock breeding range.

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Personnel from the U.S. Fish and Wildlife Service, Canadian Wildlife Service, and the many state and provincial agencies as well as various other individuals assisted in collecting the Singing-ground Survey data and processing wings at the Wing-collection "wingbee." The 1992 "wingbee" was hosted by the Kentucky Department of Fish and Wildlife Resources. Special appreciation is extended to Jeff Sole who coordinated this work session. Individuals who helped with the wingbee were: M. Olinde, F. Kimmel (Louisiana Dept. of Wildl. and Fish.); D. Dessecker (The Ruffed Grouse Society); L. Nelson (Minnesota DNR); B. Ehlers, B. Gentry, M. Harrison, D. Johnson, D. Krementz, G. Sepik, and P. Yakupzack (USFWS); T. Barnes (University of Kentucky); T. Edwards, Z. Simunovic, D. Wehr, A. Boebinger, M. Henshaw, R. Hines, C. Grasch, and M. Schroder (Kentucky Department of Fish and Wildlife Resources); V. Abel, T. Buck, R. Brewer, D. Abel, D. Dodson, and B. Moore (Eastern Kentucky University). Many woodcock hunters cooperated by sending in wings and supplemental hunting information. J. R. Sauer developed the method for calculating annual indices and refined the route regression programs for analysis of the Singing-ground Survey data. W. L. Kendall conducted the analysis, provided statistical support and reviewed earlier drafts of this report. F. Hicks provided computer programming and computer processing support. Data entry was ably conducted by S. P. Windham and the Electronic Data Processing Section of the Office of Migratory Bird Management. I am especially grateful to M. A. McKeogh, who provided valuable assistance in conducting both surveys, processing data forms, and provided secretarial support. P. Keywood prepared the figures. J. B. Bortner reviewed the manuscript and provided helpful comments. Special thanks are due the regional, state, and provincial Singing-ground Survey coordinators. Portions of this report were copied in whole or in part from previous status reports.

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Table 1. Distribution of hunters contacted and response rates in 1991-92 woodcock wing collection survey.

State of residence	Number of contacts by code[a]					Total contacts	No. of cooperators	Percent Cooperating
	1	2	4	6	9			
AL	2	11		2		15	1	7
AK	1					1	0	0
AR	5	8		3		16	2	13
CA		8		1		9	0	0
CO		6				6	0	0
CT	65	111	1	28		205	54	26
DE	4	15		1		20	6	30
DC	1			1		2	0	0
FL	2	18		4		24	2	8
GA	8	27		7		42	9	21
IL	23	76		5		104	17	16
IN	38	33		23		94	30	32
IA	16	36	1	15		68	0	0
KS	7	6		2		15	2	13
KY	12	25		7		44	15	34
LA	79	96	1	45		221	76	34
ME	85	87		37		209	87	42
MD	13	20		4		37	6	16
MA	112	140	1	37		290	91	31
MI	375	580	2	99		1056	464	44
MN	163	272	1	69		505	169	33
MS	2	18				20	1	5
MO	24	49	2	10		85	27	32
MT	2					2	0	0
NE	3	7				10	2	20
NH	58	68	1	25		152	68	45
NJ	42	74		17		133	37	28
NY	154	200	4	63		421	186	44
NC	15	47		7		69	17	25
ND	2	1				3	0	0
OH	82	48	1	20		151	57	38
OK	5	17		4		26	2	8
PA	129	348	3	40		520	140	27
RI	12	16		5		33	9	27
SC	10	29		5		44	9	20
SD		1				1	0	0
TN	12	31		4		47	10	21
TX	5	26	1	2		34	6	18
UT	1	1				2	0	0
VT	44	43		31		118	47	40
VA	30	38		13		81	26	32
WA		4				4	0	0
WV	12	3	1	3		19	9	47
WI	251	602		64		917	301	33
WY						0	0	0
Total	1906	3246	20	703	0	5875	1985	34

[a] Code 1 - Previous year's Code 1,2,4, and 9 hunters who submitted wings.
Code 2 - Waterfowl harvest survey hunters who reported hunting woodcock.
Code 4 - Requested participation or proposed by fellow hunter.
Code 6 - Previous year's Code 1 who did not submit wings.
Code 9 - From list provided by state, primarily from state harvest survey.

Table 2. Comparison of woodcock recruitment indices for 1991 against the 1963-91 averages by state and region. Woodcock recruitment indices for individual states were calculated as the ratio of immatures per adult female. The regional indices for 1991 are calculated as the average of the state values, adjusted for comparability with the 1963-1991 average.

State of harvest	Number of wings recieved		Adult females		Immatures		Immatures per adult female	
	1963-91	1991	1963-91	1991	1963-91	1991	1963-91	1991
Eastern Region								
CT	12048	135	2620	28	7432	72	2.8	2.6
DE	376	9	52	0	259	6	5.0	a
FL	657	4	148	2	410	0	2.8	a
GA	2554	37	785	13	1100	9	1.4	a
ME	65084	1156	18984	265	32628	627	1.7	2.4
MD	3376	23	822	7	1915	10	2.3	a
MA	16691	294	4956	89	8447	140	1.7	1.6
NH	22283	676	7089	195	10476	327	1.5	1.7
NJ	23178	166	5344	41	13683	86	2.6	2.1
NY	43612	896	14117	305	20720	362	1.5	1.2
NC	2471	89	716	32	1239	34	1.7	a
PA	23957	232	7382	69	11346	122	1.5	1.8
RI	2021	58	376	10	1373	34	3.7	a
SC	1787	19	523	9	920	4	1.8	a
VT	16504	441	5190	130	7858	213	1.5	1.6
VA	2789	85	596	19	1750	52	2.9	a
WV	4650	60	1394	14	2383	30	1.7	a
Region	244038	4380	71094	1228	123939	2128	1.7	1.8
Percent change								5.9%
Central Region								
AL	907	1	241	0	425	1	1.8	a
AR	454	5	152	0	185	4	1.2	a
IL	1064	38	227	12	616	20	2.7	a
IN	5726	215	1403	63	3258	93	2.3	1.5
IA	522	51	182	20	240	19	1.3	a
KS	37	0	9	0	20	0	a	a
KY	811	55	188	13	425	29	2.3	a
LA	24076	1637	5312	214	15857	1200	3.0	5.6
MI	70724	4277	22544	1406	36402	1857	1.6	1.3
MN	18633	1779	6072	552	9033	788	1.5	1.4
MS	1645	2	467	1	838	1	1.8	a
MO	1930	159	466	42	982	63	2.1	1.5
NE	10	2	4	2	5	0	a	a
OH	11053	201	3368	69	5353	72	1.6	1.0
OK	149	9	33	1	80	1	2.4	a
TN	774	36	184	5	399	23	2.2	a
TX	939	70	237	15	484	40	2.0	a
WI	47024	2122	14959	633	23486	974	1.6	1.5
Region	186478	10659	56048	3048	98088	5185	1.8	1.6
Percent change								-11.1%

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[a] Number of wings received was less than 125.

Table 3. Comparison of state and regional indices to daily and seasonal woodcock hunting success. State and regional indices are calculated for states represented by at least 10 hunters who participated in both years. Regional indices were weighted by the estimated woodcock harvest in those states.

State of residence	Number of hunters	Number of hunts		Woodcock bagged		Average bag per hunt		Average bag per season	
		1990	1991	1990	1991	1990	1991	1990	1991
Eastern Region									
CT	19	64	61	112	92	1.8	1.5	5.9	4.8
FL	0					a	a	a	a
GA	3	18	10	37	18	a	a	a	a
ME	50	247	286	494	597	2.0	2.1	9.9	11.9
MD	2	14	10	29	21	a	a	a	a
MA	33	115	117	171	184	1.5	1.6	5.2	5.6
NH	35	150	175	271	296	1.8	1.7	7.7	8.5
NJ	19	80	74	149	122	1.9	1.6	7.8	6.4
NY	72	330	320	586	539	1.8	1.7	8.1	7.5
NC	7	19	31	32	58	a	a	a	a
PA	37	151	98	307	151	2.0	1.5	8.3	4.1
RI	4	16	22	36	44	a	a	a	a
SC	2	5	5	14	10	a	a	a	a
VT	28	111	112	179	207	1.6	1.8	6.4	7.4
VA	9	29	35	43	66	a	a	a	a
WV	4	16	17	31	28	a	a	a	a
Region	324	1365	1373	2491	2433	1.9	1.7	8.2	7.3
Percent change							-10.5%		-11.0%
Central Region									
AL	0					a	a	a	a
AR	1	1	1	1	1	a	a	a	a
IL	4	19	15	32	22	a	a	a	a
IN	17	80	68	168	148	2.1	2.2	9.9	8.7
IA	3	11	8	20	14	a	a	a	a
KY	8	21	17	43	44	a	a	a	a
LA	50	247	286	494	597	2.0	2.1	9.9	11.9
MI	218	1099	1141	2515	2608	2.3	2.3	11.5	12.0
MN	84	431	502	1060	1409	2.5	2.8	12.6	16.8
MS	0					a	a	a	a
MO	10	28	37	50	97	1.8	2.6	5.0	9.7
OH	19	121	72	334	164	2.8	2.3	17.6	8.6
OK	1	1	3	2	9	a	a	a	a
TN	4	8	11	10	15	a	a	a	a
TX	3	6	5	10	7	a	a	a	a
WI	101	448	448	1089	1078	2.4	2.4	10.8	10.7
Region	523	2521	2614	5828	6213	2.3	2.3	11.6	11.6
Percent change							0.0%		0.0%

[a] Number of participating hunters was less than 10.

Table 4. Trends (% change per year[a]) in number of American woodcock heard in the Singing-ground Survey as determined by the route regression technique.

State, Province, or Region	2-year trend (1991-92)			8-year (1985-92)		25-year (1968-92)	
	# routes[b]	N[c]	% change	N	% change	N	% change
CT	4	2	-7.5	4	-14.1 **[d]	10	-7.7 **
DE	1	0	--	0	--	3	-33.9
ME	51	36	-18.8 **	57	-3.1 *	63	-2.1 **
MD	9	4	-76.8 ***	10	-13.4	24	-7.2 ***
MA	16	12	-12.6	14	-5.1 **	20	-4.4 *
NB	44	33	-7.3	51	1.0	63	-2.0 **
NH	9	8	-25.2 **	16	1.0	18	-2.1
NJ	9	3	-35.1	13	-19.1 ***	18	-7.7 ***
NY	59	36	-17.0 *	78	0.2	106	-1.3
NS	36	20	9.4	40	-1.2	55	-2.1 *
PA	40	10	-35.4 *	29	-3.6	68	-4.2 ***
PEI	9	3	12.8	11	-1.5	13	0.7
QUE	0	0	--	29	4.0	68	3.4 **
RI	0	0	--	0	--	3	-7.7 ***
VT	20	16	-37.2 ***	19	-1.1	22	-3.2 **
VA	23	4	8.2	25	-2.7	71	-6.8 ***
WV	22	10	-18.8	27	-4.6	48	-1.1
Eastern	352	197	-16.1 ***	424	-0.8	673	-1.9 ***
IL	19	4	-10.3	17	-19.0	38	-2.4
IN	22	6	-16.1	20	10.3 *	51	-1.3
MI	120	89	-21.6 ***	127	0.1	138	-0.6
MN	67	43	-14.4 **	78	0.4	107	0.3
OH	34	20	-4.4	33	-3.9	69	-4.3 *
ON	79	61	-9.3 *	124	-1.4	137	-0.4
WI	75	55	-23.2 ***	85	-2.5 **	111	-1.7 **
Central	416	278	-16.8 ***	484	-0.7	651	-0.8
Continental	768	475	-16.6 ***	908	-0.7	1324	-1.2 **

[a] Mean of weighted route trends within each State, Province, or Region. To estimate the total percent change over several years, use: $100(\%/100+1)^y-100$ where % is the annual change and y is the number of years.

[b] Total number of routes which were run and received prior to 6/1/92.

[c] Number of routes comparable in at least two years with one or more counts greater than zero.

[d] Indicates slope is significantly different from zero: * $P<0.10$, ** $P<0.05$, *** $P<0.01$; significance levels are approximate for states where $N<10$.

Table 5. Breeding population indices for American woodcock from Woodcock Singing-ground Survey, 1968-1992. Annual indices are calculated as the predicted value from the trend analysis plus the difference between the observed value and predicted value for each year.

State, Province, or Region	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
Eastern Region													
CT [b]	--[a]	3.84	3.71	3.06	3.88	2.90	2.88	3.08	1.70	1.82	1.20	1.22	1.07
DE [b]	72.97	42.50	39.47	24.39	9.49	15.82	19.64	5.42	1.66	1.78	1.33	1.02	--
ME	4.75	4.79	5.15	4.60	4.52	4.70	4.64	5.01	4.44	3.98	3.66	3.99	3.56
MD	3.42	3.18	2.88	2.59	2.35	2.62	2.11	2.31	1.57	1.56	1.70	1.40	1.57
MA	--	3.15	3.69	4.32	3.16	4.24	3.42	2.01	2.65	1.94	2.34	2.55	1.83
NB	--	5.82	6.12	5.65	5.93	5.12	5.59	6.40	4.67	5.66	4.17	4.47	4.11
NH	--	3.75	4.35	3.47	4.18	3.20	4.25	3.53	4.20	3.45	3.44	3.40	3.80
NJ	4.25	3.13	4.76	5.83	3.69	5.25	5.12	3.86	2.54	2.80	1.66	2.87	1.71
NY	3.93	4.38	3.28	3.76	3.61	3.65	3.87	3.35	3.38	3.58	2.79	3.23	3.71
NS	4.36	2.90	2.50	3.04	2.88	2.74	3.39	2.89	2.48	2.46	2.66	2.24	2.07
PA	2.40	2.15	2.49	2.06	1.90	1.95	1.48	1.74	1.60	1.61	1.26	1.43	1.33
PEI	--	2.63	2.25	2.93	2.47	1.97	2.67	4.14	3.67	3.23	2.59	3.17	2.35
QUE	--	--	--	2.71	2.53	2.07	2.41	2.56	1.93	2.17	2.76	2.81	3.14
RI [b]	--	0.90	1.07	1.69	1.45	1.45	1.08	0.83	0.83	--	0.28	0.48	0.48
VT	--	2.89	4.89	3.58	4.14	3.45	3.36	3.79	3.42	4.05	3.07	2.88	2.53
VA	--	1.87	1.96	1.55	1.40	1.06	1.58	1.40	1.15	1.24	0.90	1.04	0.86
WV	1.22	1.40	1.03	0.97	1.19	0.97	0.95	1.09	0.99	1.02	0.70	1.02	0.86
Region	3.25	3.13	3.11	2.99	2.94	2.79	2.95	2.97	2.57	2.67	2.24	2.49	2.34
Central Region													
IL	--	--	0.38	0.39	0.38	0.37	0.30	0.40	0.31	0.31	0.30	0.32	0.25
IN	1.29	0.99	0.94	0.75	0.97	1.02	0.82	0.85	0.93	0.91	0.83	1.08	0.84
MI	5.07	4.98	4.80	4.64	4.49	4.68	5.42	5.55	5.11	4.79	5.01	5.09	5.04
MN	--	3.36	2.80	3.31	2.77	3.05	4.16	3.45	3.22	3.31	3.39	3.40	3.65
OH	--	--	2.12	2.15	1.82	1.55	1.96	1.52	1.66	1.95	1.53	1.21	1.21
ON	5.06	5.67	5.39	5.16	5.63	5.22	5.55	5.11	4.91	5.41	5.96	5.61	5.99
WI	3.64	3.54	3.82	3.36	3.22	3.30	3.37	3.24	3.11	3.45	3.57	3.47	2.98
Region	3.12	3.06	3.03	2.91	2.84	2.83	3.13	2.98	2.86	2.97	3.00	2.96	2.91
Continent	3.13	3.05	3.03	2.92	2.86	2.79	3.01	2.96	2.69	2.80	2.58	2.71	2.60

[a] Insufficient data or data not available as of 6/1/92.

[b] Annual indices are approximate due to low sample size.

Table 5. Continued.

State, Province, or Region	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
Eastern Region												
CT [b]	1.44	1.88	1.45	1.07	0.99	1.36	0.78	1.59	0.70	0.65	0.73	0.48
DE [b]	--	--	4.53	0.12	0.08	--	--	--	--	0.02	0.00	0.00
ME	3.90	2.71	3.52	3.46	3.46	3.67	3.95	3.70	3.76	2.63	3.36	2.77
MD	1.51	1.50	1.04	0.91	0.91	0.79	0.73	0.90	0.76	0.85	0.88	0.29
MA	1.86	1.58	1.17	2.08	1.62	1.71	1.80	1.79	1.39	1.24	1.48	1.22
NB	4.18	4.20	4.43	3.79	3.97	3.32	3.86	3.81	5.15	4.01	3.93	3.82
NH	4.20	2.40	2.77	2.46	2.61	4.31	2.92	2.98	2.92	2.51	3.26	2.09
NJ	1.43	1.72	1.62	1.88	1.40	1.48	1.69	1.24	1.26	0.87	0.83	0.61
NY	3.46	2.76	3.37	2.58	3.36	2.87	2.56	3.02	2.41	2.89	3.03	2.75
NS	1.94	1.66	2.11	2.11	2.06	2.39	2.12	2.24	2.34	1.75	1.87	2.22
PA	1.31	1.12	1.23	1.29	1.02	1.22	1.16	1.11	0.91	1.09	1.15	0.85
PEI	1.84	2.02	3.14	3.37	2.72	3.72	3.01	4.33	3.80	3.24	2.60	2.58
QUE	2.63	2.60	3.41	3.00	3.37	3.53	3.72	3.95	3.93	3.55	--	--
RI [b]	0.28	1.16	0.66	0.70	0.23	0.23	--	0.33	0.33	--	0.23	--
VT	2.21	1.63	2.37	2.46	1.83	2.26	2.32	2.72	2.60	2.44	2.36	1.58
VA	0.93	0.90	0.78	1.11	0.60	0.61	0.66	0.51	0.49	0.45	0.48	0.40
WV	1.17	1.05	1.11	0.90	0.87	0.83	0.97	0.77	0.80	0.88	0.82	0.80
Region	2.34	2.04	2.34	2.22	2.15	2.21	2.20	2.26	2.17	2.00	2.12	1.86
Central Region												
IL	0.28	0.21	0.32	0.23	0.36	0.27	0.35	0.24	0.28	0.17	0.29	0.24
IN	0.90	0.69	0.72	0.73	0.62	0.86	0.62	0.69	0.69	0.77	0.88	0.77
MI	4.21	4.46	3.89	4.33	4.52	4.62	4.24	4.53	4.40	4.32	5.24	3.81
MN	3.48	3.24	2.91	2.61	3.06	3.35	3.12	3.65	3.20	3.68	3.44	2.88
OH	1.40	1.04	1.40	1.27	1.11	0.90	0.98	1.14	0.85	1.19	0.88	0.82
ON	5.76	4.32	4.47	4.77	4.79	4.92	4.96	4.95	5.10	5.07	4.96	4.84
WI	2.58	2.50	2.51	2.73	2.52	2.99	2.97	2.98	2.72	2.74	2.67	2.05
Region	2.72	2.42	2.40	2.48	2.51	2.64	2.55	2.69	2.55	2.64	2.71	2.26
Continent	2.52	2.23	2.37	2.35	2.34	2.43	2.39	2.49	2.37	2.34	2.43	2.08

[a] Insufficient data or data not available as of 6/1/92.
[b] Annual indices are approximate due to low sample size.

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